A Computerized Interactive Toy: TSU.MI.KI

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Abstract. Young children often build various structures with wooden blocks; structures that are often used for pretend play, subtly improving children's creativity and imagination. Based on a traditional Japanese wooden block toy, Tsumiki, we propose a novel interactive toy for children, named "TSU.MI.KI", maintaining the physical assets of wooden blocks and enhancing them with automation. "TSU.MI.KI" consists of a set of computerized blocks equipped with several input/output devices. Children can tangibly interact with a virtual scenario by manipulating and constructing structures from the physical blocks, and by using input and output devices that are integrated into the blocks.

1 Introduction

Young children often construct various structures with blocks and also play with the constructed structure in pretend play. As an example of such blocks, we have Tsumiki-toy which is a Japanese traditional toy made of wooden blocks. Despite Tsumiki's simple form, children assemble and play with it, while at the same time unconsciously learn and enhance their creativity and imagination. However, since the toy consists of wooden blocks, the interaction has been limited to be only one-way – from children to Tsumiki blocks. If this interaction could be bi-directional and supported by rich multimedia contents on a computer, it could stimulate children's creativity and imagination even further.

On the other hand, in order to realize intuitive interaction with computers, approaches of direct manipulation have been focused on. These approaches can make user interfaces easy to learn, to use, and to retain over time [1]. Based on this idea, researches have recently commenced on user interfaces that use physically substantial objects to improve the intuitiveness of interactions with the computer [2]–[4]. Such interfaces do not require computer expertise, nor do they depend on users' cultural background and age. In addition, if the shapes of these interfaces in the physical environment matched their representation and function in cyberspace, users could interact with cyberspace via these physical objects more intuitively and easily.

Our main research goal is to bridge the gap that separates cyberspace and the physical environment by using physical objects as user interfaces. In this paper we present such interface, "TSU.MI.KI", a novel interactive story-telling system

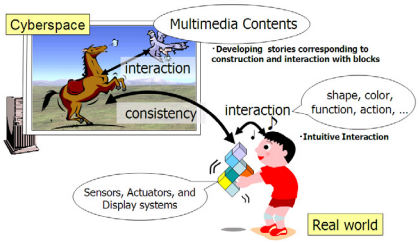

Fig. 1. Overview.

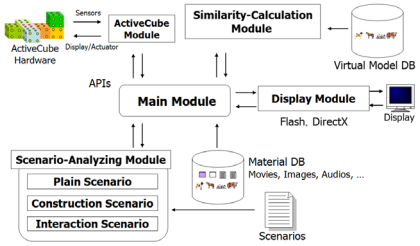

Fig. 2. System architecture.

for stimulating children's creativity and imagination by supporting multimedia contents intuitively and easily (see in Fig. 1).

2 TSU.MI.KI.

We describe TSU.MI.KI's general flow of events. First, by using a set of computerized blocks, children construct a shape with which they want to play in cyberspace. The computer automatically recognizes the constructed structure in real time, and then retrieves some candidate 3D virtual models closely matching the constructed structure. After that, children select one of the candidates, and the computer starts to play the virtual model's multimedia contents. Children can play in cyberspace while holding the constructed object in their hands. This interaction is supported by input and output devices fitted to each block, and by the computerized cube structure being self-aware of its geometry. In order to realize this system, we have designed the system architecture shown in Fig. 2.

The TSU.MI.KI system supports this flow of events in all its applications by three different scenarios that follow each other sequentially: plain, construction and interaction scenarios. The plain scenario displays non-interactive contents, such as a movie, an image or a music clip, explaining to the children what happens in cyberspace. In the construction scenario, children construct a shape with which they want to play in cyberspace. The computer then displays candidate virtual models that closely match the constructed structure. After children choose one of the candidates in the construction scenario, the interaction scenario starts playing. In this scenario, children play in cyberspace with the structure they constructed earlier through input and output devices fitted to each block.

To allow children to input the shape with which they want to play and input their intention into the interaction scenario, and to show the result of children's interaction to them, we use the ActiveCube system [5] as the physical object. All scenarios for the application are defined and recorded as files on the computer in advance. In the construction scenario, children construct their desired shape tangibly, and the ActiveCube module recognizes its structure in real time. After that, the main module gives data of the structure to the similarity-calculation module, which calculates similarities between all of the virtual models and the constructed structure by using a method [6]. The main module acquires the

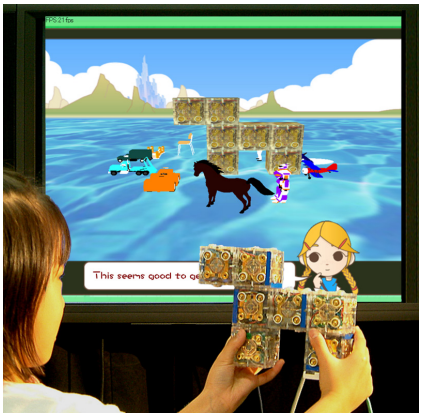

Fig. 3. Shape selection from several candidates.

Fig. 4. Interaction with ship.

results of this calculation and presents some virtual model candidates corresponding to the results. The display module presents TSU.MI.KI's multimedia and virtual contents. To realize an immersive environment for children, the display module is designed to be capable of presenting realistic and interactive multimedia contents.

3 Application

We expect that the TSU.MI.KI system can be applied to various applications for children and can stimulate children's creativity and imagination. As one typical example of this system and to provide confirmation of our assumptions and claims, we implemented an application that consists of one quest with several scenarios. The application follows this story outline:

A girl, Alice, has lost her way home and has been wandering in a magical world. Then, she encountered an elderly lady, who was a good witch. The witch gave her magical blocks to help her overcome difficulties on her way home. When she constructs an object with these magical blocks to form a desired shape, it transforms itself into an object that forms the same shape as the constructed blocks. Next, Alice faces a wide river and somehow has to cross it. How can she get across this wide river, and can she reach her home safely?

In order to implement this story-telling application, we prepared seven scenarios: three plain, one construction, and three interaction scenarios. Fig. 3 shows a scene which a girl is constructing and selecting her desired object.

At first, a plain scenario explains the situation that the children are facing by presenting some images; the scenario explains the approximate story as described above and displays to the children the wide river and indicates the need to cross it.

Then, in the construction scenario, they construct a shape which they consider the most appropriate to get Alice across the river, using trial and error

(repetitions of connection and disconnection of blocks). The constructed shape is transformed into several virtual objects as candidates in real time.

After completing construction, the children have to select one of the appropriate objects from the presented candidates. The current selected object is changed by rotating the circle of candidates and executed by tilting the physical object to the right or to the left. When they decide on their desired object, they push down on the physical object. The scenario branches off corresponding to the chosen object into three interaction scenarios.

The interaction scenario shown in Fig. 4 is the most specific and novel part of the TSU.MI.KI system. With the traditional Tsumiki wooden block toy, children only play in their imagination with static blocks; there is no response from blocks and no spread of the story. In contrast, the TSU.MI.KI system enables children to play in cyberspace, where there are no limitations to representation and imagination.

4 Conclusion

In this paper, we proposed a novel user interface named TSU.MI.KI that bridges the gap between cyberspace and the physical environment, and provide a unique and innovative"edutainment" (educational-entertainment) experience for children. We briefly described the design approach and implementation method of our system and of the prototype quest game that used it as infrastructure.

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